

# PATENT SPECIFICATION

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DRAWINGS ATTACHED.

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## COMPLETE SPECIFICATION.

### Manufacture of Artificial Board Having a Core Sandwiched Between Two Layers of Sheet Material.

We, DIAMOND CARBIDE COMPANY LIMITED, a British Company, of Old Bowlish House, Shepton Mallet, Somerset, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to the manufacture of artificial board of the kind containing a certain proportion of a resinous binding agent.

Various artificial boards of this type are known which are manufactured by mixing a filler, such a mixture of wood chips and sawdust, with an aqueous solution or suspension of a partially condensed thermosetting resin and then progressively heating and compressing the mixture to drive off the water, to reduce the mixture to the desired final thickness and to cure the resin to the thermoset condition. Considerable heat and pressure, and consequently elaborate apparatus, are needed in order to effect complete curing of the resin and as a result plants for the manufacture of such board take up a great deal of space and are very costly. Furthermore such plants are normally adapted to make only board of a single given width and thickness and considerable and troublesome modification is required if board of, say, a different thickness from that usually produced, is required.

This invention consists in artificial board consisting of a core containing a major proportion of a filler of small particle size and 10%—50% by weight of a partially-condensed thermosetting resinous binder uniformly distributed therethrough formed by

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heating and compressing a dry mixture of powdered resinous binder and filler, the core being sandwiched between two layers of sheet material, and said board having voids but being hard and having sufficient strength to be handled and mechanically worked.

This invention also consists in a method for the continuous production of such board, which comprises metering a layer of an intimate dry mixture comprising a major proportion of a filler of small particle size and 10%—50% by weight of a powdered partially-condensed thermosetting resinous binder onto a web of sheet material carried by an endless conveyor belt, heating the uniform layer of powdered material so produced during its travel on the conveyor melt, applying a second web of sheet material to the top of the layer, and then progressively compressing and heating the assembly so formed during its travel on the conveyor belt to form it into a board of the desired thickness, the application of the said heat and pressure being sufficient to melt the resinous binder at least momentarily to produce a board which has voids but is hard and has sufficient strength to be handled and mechanically worked, but insufficient to effect complete condensation of the thermosetting resinous binder.

It is known to make a board in which a core is sandwiched between two layers of sheet material—this can produce a board having an attractive appearance and a surface which is at least partly protected by the sheet material, and can also enable the core materials to be controlled more easily during the manufacturing process, i.e. dur-

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ing heating and compression. It is also known to form the core from a dry mixture of powdered resin and a filler, and this in itself can simplify and cheapen the plant compared to plant required for making board using a wet mixture of resin and filler.

With this invention, a satisfactory product can be obtained using much less rigorous conditions of heating and pressure than have been used hitherto. This feature is based on the discovery that even if complete hardening of the resinous binder is omitted, it is possible to obtain a board having sufficient strength to be handled and mechanically worked, as by sawing and drilling, provided there is at least 10% by weight of the resinous binder in the core, and on the appreciation that the heat and pressure which are necessarily employed in laminating artificial board of this type to other sheet materials, such as wood veneers, glass fibre, metal sheet and melamine-formaldehyde resin-containing paper (such subsequent lamination being a major outlet for board of this type) can be used to bring about the final curing of the resinous binder, in addition to laminating such sheet materials to the board.

By using a dry process and by omitting the complete hardening of the resinous binder, we have greatly simplified the apparatus required for production of the board and the apparatus for carrying out a process according to this invention need only take up only a fraction of the space of plant for the production of some known types of artificial board, can cost considerably less than the cost of some known plant, and, in addition, can be readily adjusted to produce artificial board of a variety of thicknesses and widths.

The last stage of this method of this invention, namely the progressive compressing and heating of the assembly of the layer of heated material between the two webs of sheet material, is advantageously effected by passing the assembly under the lower run of a second endless belt arranged above the conveyor and run at the same speed as the first conveyor belt, said lower run being inclined with respect to the first conveyor belt with its downstream end spaced from the first conveyor belt by a distance equal to the desired thickness of the board and the roll supporting the downstream end of the second belt and a roll supporting the first conveyor belt vertically therebelow being maintained at a temperature above the melting point of the resinous binder, whereby as the assembly passes under the second belt it is progressively compressed to the desired final thickness and the resinous binder therein is,

during the final stage of compression, melted.

Fillers of small particle size may be powdered whether they are fibrous or not. Substantially any powdered filler may be employed in the manufacture of artificial board according to the invention and the choice of filler is largely dictated by the properties which the final board is required to have; the only requirement the filler must fulfil is that it should be readily available and should permit a board having the properties of strength and hardness mentioned above to be obtained with less than 50% of resinous binder. As the cost of the binder is much greater than that of the filler the proportion of the former should be reduced as much as possible in order to reduce the cost of the artificial board as a whole; in general if the board contained more than 50% of resinous binder its price would be uneconomic and it is for this reason that we have specified that the board should contain less than 50%, of the resinous binder. For the same reason, it is preferred to employ fibrous fillers as the particles of these fillers have a natural tendency to adhere together and this reduces the proportion of resin which is required to obtain a board having the above-mentioned properties of hardness and strength. Suitable fillers are, for example, of the non-fibrous kind, diatomaceous earth, and of the fibrous kind bagasse, sawdust, asbestos, shive waste (waste from the processing of flax), maize husks and straw. The use of bagasse gives a cheap, light, artificial board, sawdust, a cheap board which is somewhat heavier than that produced from bagasse; and asbestos, a non-inflammable board which is relatively heavy after the subsequent hot pressing operation; all other fillers give end products having properties intermediate between the properties of the artificial boards obtained with these three fillers. Before use the filler and the resinous binder are thoroughly powdered by dry grinding and the two are then thoroughly blended together to form a homogeneous mixture.

A wide variety of thermosetting resinous binders may be employed in the production of artificial board according to the invention and suitable resins are, for example, phenol-formaldehyde, urea-formaldehyde and melamine-formaldehyde resins. As will be apparent from the foregoing discussion, the proportion of resinous binder employed is related to the nature of the filler and in general it may be said that the proportion of resinous binder employed should be the minimum compatible with obtaining the required properties of hardness and strength in the product. For most fillers, a suitable proportion of resinous

binder is in the range 10% to 30% by weight.

Although the filler and the resinous binder are the major constituents of the artificial board, small proportions of other materials may be incorporated therein for particular purposes, for example pigments. A typical composition of artificial board according to the invention is, for example, 70% by weight of powdered bagasse or other fibrous filler, 20% by weight of powdered thermosetting resinous binder, and 10% by weight of powdered pigment.

The primary purpose of the webs of sheet materials between which the core of filler/thermosetting resinous binder mixture is placed is to prevent the mixture adhering to the apparatus during production of the board; when the thermosetting resinous binder is heated it becomes tacky and if such webs of sheet material were not present above and below the powdered mixture, the mixture would adhere to the conveyor and other parts of the apparatus and production of the board would be impossible. The webs of sheet material may, however, also be employed to give a decorative and/or reinforcing effect to the surfaces of the artificial board and for this purpose the webs may be formed of paper, woven or unwoven fibre, glass fibre, cloth or plastics material. Where the artificial board is to be laminated following production to other materials, such as wood veneers, glass fibre, metal sheet or melamine-formaldehyde resin-containing paper, and/or no such decorative or reinforcing effect is required it is preferred to employ the cheapest and thinnest sheet material possible in order to reduce the overall cost of the artificial board and for this purpose it is therefore preferred to use webs of tissue paper to sandwich the filler/thermosetting resinous binder mixture.

As stated above the product of this invention is an artificial board containing partially-condensed thermosetting resinous binder and is sufficiently strong to be handled and mechanically worked. Where this product is to be shipped prior to lamination and final curing, it is found in some cases that the degree of cure obtained in producing the board does not provide sufficient strength for the board to withstand the rough handling it is liable to be subjected to during shipment. Where for this or any other reason a stronger product is required, the board as it comes from the above-described apparatus is cut into lengths and the lengths of board are subjected to a short curing treatment under light pressure. It is important to avoid complete curing during this treatment as one of the advantages of the product according to the invention is that it is deform-

able (owing to the resinous binder not being fully hardened) under heat and pressure and it is thus able to take up irregularities in the sheet material and the press in the subsequent laminating operation, and this advantage would be lost if the resinous binder in the board was fully hardened before the laminating operation. Where the board is not shipped prior to lamination with other sheet materials, such a short curing treatment will not normally be necessary.

The board of this invention may contain a substantial number of coils such that it can be compressed to about half its thickness.

In order that the invention may be more fully understood, a preferred embodiment of apparatus for the production of artificial board will now be described, by way of example only, with reference to the accompanying drawing in which the single Figure is a diagrammatic elevation of such apparatus.

Referring to the drawing, the apparatus comprises a wire mesh endless conveyor belt 1 supported on an idling roller 2 and a heated roller 3 and having a width for example, of 60 inches. A hopper 4 provided with means for regulating the discharge of material therefrom is positioned above one end of the upper run of the conveyor 1 and spaced therefrom along the conveyor is a metering device including two vertical plates 5 and 6 which extend across the width of the conveyor. The separation of both plates 5 and 6 from the upper run of the conveyor 1 is adjustable and the plate 5 is arranged for reciprocation across the conveyor in a horizontal plane at pre-adjusted height from the conveyor, whilst the plate 6 is arranged for vertical reciprocation about a pre-adjusted means position above the conveyor; for this purpose the plates 5 and 6 are connected to conventional means (not shown) for effecting such horizontal and vertical reciprocation respectively. Further along the conveyor, heating elements 7 are provided above and below the upper run; these heating elements may be electric strip heaters, induction heating elements, steam heated platens or any other convenient form of heating element.

Still further along the conveyor, a pressing device 8 is positioned above the upper run, this pressing device comprising a second wire mesh endless belt 9 having the same width as the conveyor 1 and supported by a heated drive roller 10 and a roller 11. The lower run of the second belt 9 is inclined with respect to the upper run of the conveyor, the inclination being such that the distance between the lower run of the belt 9 where it passes round the

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roller 11 and the upper run of the conveyor is somewhat greater than the thickness of the heated layer of powdered material which, in operation, issues from the heating element 7, while the distance between the two belts where they pass over the lowermost point of the heated roller 10 and the uppermost point of the heated roller 3 respectively is equal to the desired thickness of the board. The roller 10 is positioned vertically above the roller 3 so that effective pressure is applied to the material passing through the nip between these two rollers; a rigid support 12 is provided under the upper run of the conveyor 1 to co-operate with the rest of the pressing device 8. The roller 10 is provided with means (not shown) for adjusting its vertical displacement from the roller 3 in order that boards of various thicknesses may be readily produced.

The apparatus further comprises a take-off reel 13 from which a web 14 of sheet material, such as tissue paper, is fed onto the upper run of the conveyor before material is applied thereto by the hopper 4 and a take-off reel 15 from which a second web 16 of sheet material, such as tissue paper, is fed onto the upper surface of the layer of powdered material as the latter passes under the pressing device 8. Beyond the discharge end of the conveyor 1, a cutting table 17 and a knife or other cutting device 18 are provided. The lower run of the conveyor 1 is provided with conventional tensioning means (not shown).

In operation, the mixture of powdered filler and powdered thermosetting resin is introduced into the hopper from which it is discharged onto the web 14 carried by the upper run of the conveyor 1 in the direction indicated by the arrow. As the mass of powdered material passes under the reciprocating plates 5 and 6 it is reduced to a layer of uniform thickness, the thickness of the layer being determined by the height of the plates 5 and 6 above the upper run. The layer of powdered material passes between the heating elements 7 whereby it is heated to a temperature approaching, but a little below, the melting point of the resin; the length of the heating elements along the conveyor, the heating capacity of the heating elements and the speed of travel of the conveyor are preferably so adjusted that on emerging from the heating elements the powdered material is at a temperature of from 180° F. to 230° F. The second web 16 is then applied to the upper surface of the heated powdered material and the assembly so formed then passes under the second belt 9, which travels in the direction indicated by the arrow at the same speed as the conveyor 1, and is progressively compressed

until it is reduced to the desired final thickness. The final compression of the assembly is effected by the heated rollers 10 and 3 which are maintained at a temperature above the melting point of the resin, for example, at a temperature of 330° F: as the assembly passes through the nip between these rolls, the resin is momentarily melted and the major part of the reduction in thickness to the desired final value takes place. As an indication of the extent of compression, in a typical run the initial thickness of the layer of powdered material was  $\frac{3}{4}$  inch (approx. 20 mm.) while the final board had a thickness of  $\frac{1}{4}$  inch (approx. 6 mm); after laminating a board of this thickness would be reduced to a thickness of about  $\frac{1}{8}$  inch (approx. 3 mm.).

The material emerges from the pressing device as a continuous "green" board which is hard and capable of being cut into lengths, for which purpose it is delivered onto the cutting table 17 where it is cut into suitable lengths by the knife 18.

In carrying out the foregoing process it is important that the powdered material should not be raised to too high a temperature by the heating elements 7 as otherwise there is a danger of the resin in the outer parts of the layer becoming fully cured either as the material passes between the heating elements themselves or when it passes between the heated rollers 10 and 3. At the same time some pre-heating of the powdered material before it passes under the pressure device is essential as effective compression and the development of the required mechanical properties in the board can only be obtained if the resin is liquefied and this could not be brought about by the heat supplied by the heated rollers 10 and 3 alone. A balance has therefore to be struck between the application of too much heat which would cause some part of the resin to become fully cured and the application of too little heat which would not enable the whole of the resin to be melted and would thus prevent the production of a compact, void-free board having the desired properties of hardness and mechanical strength; operation of the apparatus in the manner described above avoids these two extremes of over-heating and under-heating.

When the "green" board produced as described above is to be shipped prior to lamination with other sheet materials, the cut lengths of board are conveyed from the table 17 to a heated press and are subjected in the press to a short curing treatment under light pressure. For example the lengths of board can be held under contact pressure at a temperature of about 300° F for about 2 minutes; it is important

that this treatment should not be carried out so as to harden the resin fully. This short curing treatment gives a board which, while still being "green", is strong enough to withstand shipment.

# WHAT WE CLAIM IS:—

1. Artificial board consisting of a core containing a major proportion of a filler of small particle size and 10%—50% by weight of a partially-condensed thermosetting resinous binder uniformly distributed therethrough formed by heating and compressing a dry mixture of powdered resinous binder and filler, the core being sandwiched between two layers of sheet material, and said board having voids but being hard and having sufficient strength to be handled and mechanically worked.
2. Artificial board according to claim 1, in which the filler is diatomaceous earth, sawdust, powdered asbestos or powdered shive waste.
3. Artificial board according to claim 1, in which the filler is bagasse.
4. Artificial board according to any one of the preceding claims, which contains 10% to 30% by weight of the resinous binder.
5. Artificial board according to any one of claims 1 to 3, in which the sheet material is woven or unwoven fibre, glass fibre, cloth or plastics material.
6. Artificial board according to any one of claims 1—4, in which the sheet material is paper.
7. Artificial board according to any of the preceding claims, in which the core material also includes up to 10% by weight of pigment.
8. Artificial board according to any one of the preceding claims, which contains a substantial number of voids such that it can be compressed to about half its thickness.
9. An article made using the board according to any one of the preceding claims, the resinous binder being fully cured when making the article.
10. A method for the continuous production of artificial board as claimed in any one of claims 1—8, which comprises metering a layer of an intimate dry mixture comprising a major proportion of a filler of small particle size and 10%—50% by weight of a powdered partially-condensed thermosetting resinous binder onto a web of sheet material carried by an endless conveyor belt, heating the uniform layer of powdered material so produced during its travel on the conveyor belt, applying a second web of sheet material to the top of the layer, and then progressively compressing and heating the assembly so formed during its travel on

the conveyor belt to form it into a board of the desired thickness, the application of the said heat and pressure being sufficient to melt the resinous binder at least momentarily to produce a board which has voids, but is hard and has sufficient strength to be handled and mechanically worked, but insufficient to effect complete condensation of the thermosetting resinous binder.

11. A method according to claim 10 in which the dry mixture is metered by metering means including two spaced vertical plates extending across the width of the conveyor belt, the upstream plate being arranged for reciprocation across the conveyor belt, at a pre-adjusted height above the conveyor and the downstream plate being arranged for vertical reciprocation about a pre-adjusted mean position above the conveyor belt.

12. A method according to either claim 10 or claim 11, in which the uniform layer of powdered material is heated during its travel on the conveyor belt by heating elements which are arranged above and below the upper run of the conveyor belt.

13. A method according to any one of claims 10—12, in which said compressing and heating of the assembly are effected by passing the latter under the lower run of a second endless belt arranged above the first conveyor belt and run at the same speed as the first conveyor belt, said lower run being inclined with respect to the upper run of the first conveyor belt with its downstream end spaced from the upper run of the first conveyor belt by a distance equal to the desired thickness of the board and the roll supporting the downstream end of the second belt and a roll supporting the first conveyor belt vertically therebelow being maintained at a temperature above the melting point of the resinous binder, whereby as the assembly passes under the second belt it is progressively compressed to the desired final thickness and the resin therein is, during the final stage of compression, melted.

14. A method according to claim 13 in which prior to being compressed, the powdered material is heated to a temperature of from 180° to 230° F. and in which said heated rolls are maintained at a temperature of approximately 300° F.

15. A method according to claim 13 or claim 14, in which the axis of said roll supporting the downstream end of the second belt is vertically adjustable to permit the production of boards of different thicknesses.

16. A method according to any one of claims 10—15, in which the board produced is subjected to a curing treatment under light pressure in order to increase

its strength while avoiding complete hardening of the resin.

17. A method according to claim 16, in which said treatment consists of holding the board in a press under contact pressure at a temperature of approximately 300° F.

18. Artificial board according to claim 1, and produced by a method as claimed in any one of claims 10—17.

19. Artificial board according to claim 1 and substantially as herein described. 10

20. A method for the continuous production of artificial board substantially as herein described with reference to the accompanying drawing. 15

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*

